DRAFT

Fish and Wildlife Plan

for the

MILWAUKEE ESTUARY AREA OF CONCERN

December 2013

Wisconsin Department of Natural Resources
Office of the Great Lakes

Draft Fish and Wildlife Plan
for the
Milwaukee Estuary Area of Concern

Compiled by **Megan O'Shea, WDNR**

With Input and Contributions From:

The Milwaukee Estuary Fish and Wildlife Technical Team
Facilitated by Megan O'Shea

Ann Brummitt, Milwaukee River Greenway Coalition
Marsha Burzynski, WDNR
Gary Casper, Milwaukee River Greenway Coalition
Steve Choy, U.S. Fish and Wildlife Service
Noel Cutright, Western Great Lakes Bird and Bat Observatory
Andy Fayram, WDNR
John Janssen, UW-Milwaukee
Marty Johnson, WDNR
Joanne Kline, WDNR
Chris Magruder, Milwaukee Metropolitan Sewerage District
John Masterson, WDNR
Bre McDonald, Milwaukee Metropolitan Sewerage District
Theresa Morgan, River Revitalization Foundation
Cheryl Nenn, Milwaukee Riverkeeper
Vic Pappas, WDNR
Brian Russart, Milwaukee County
Tom Slawski, Southeastern Wisconsin Regional Planning Commission
Andrew Struck, Ozaukee County
Dan Sullivan, U.S. Geological Survey
Will Wawrzyn, WDNR

Comment [MCO1]: Will be revised.

Disclaimer: The Great Lakes Water Quality Agreement is a non-regulatory agreement between the U.S. and Canada, and criteria developed under its auspices are non-regulatory in nature. Any actions identified in this document as needed to remove the impaired beneficial uses are not subject to enforcement or regulatory actions.

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

List of Acronyms

AOC	Area of Concern
BCOC	Bioaccumulative chemicals of concern
BUI	Beneficial Use Impairment
CDF	Confined disposal facility
CSO	Combined sewer overflow
GLRI	Great Lakes Restoration Initiative
GLWI	Great Lakes Water Institute
km	Kilometers
LOEL	Lowest observable effect level
mg/L	Milligrams per liter
MMSD	Milwaukee Metropolitan Sewerage District
NOAA	National Oceanic and Atmospheric Administration
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
RAP	Remedial Action Plan
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SIG	Stakeholder Input Group
SWWT	Southeastern Wisconsin Watersheds Trust (also known as Sweet Water)
TMDL	Total Maximum Daily Load
TP	Total phosphorus
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UWM	University of Wisconsin-Milwaukee
WDNR	Wisconsin Department of Natural Resources
WisCALM	Wisconsin Consolidated Assessment and Listing Methodology

EXECUTIVE SUMMARY

The purpose of this Fish and Wildlife Population and Habitat Plan (Plan) is to outline a path to removing the "**degradation of fish and wildlife populations"** and the **"loss of fish and wildlife habitat"** beneficial use impairments (BUIs) from the Milwaukee Estuary Area of Concern (AOC). The need for this plan was established in the March 2008 *Delisting Targets for the Milwaukee Estuary Area of Concern*. This plan will eventually meet all requirements of those targets by:

- Defining the causes of all population impairments within the AOC
- Establishing site-specific local population targets for native indicator fish and wildlife species within the AOC
- Establishing a list of projects that must be implemented to address the loss of fish and wildlife habitat impairment
- Identifying all fish and wildlife population/habitat restoration programs/activities within the AOC and establishing a mechanism to assure coordination among all these programs/activities, including identification of lead and coordinative agencies
- Establishing a time table, funding mechanism, and lead agency responsibility for all fish and wildlife population/habitat restoration activities needed within the AOC

We expect to meet all the requirements of the targets for this plan once the fish and wildlife populations assessments are completed. The assessments are expected to be completed by 2017. Targeted fish species for management in the AOC include lake sturgeon, walleye, greater redhorse, and northern pike. Target species for wildlife are being developed and will be included once they are available in the annual updates to this plan.

INTRODUCTION AND PURPOSE STATEMENT

One of the fundamental challenges of the Great Lakes Remedial Action Program is being able to determine when an Area of Concern (AOC) has recovered such that the AOC designation can be lifted (a process known as AOC Delisting). In 2008, DNR and its partners took the first step toward developing goals and targets for each of the beneficial use impairments (BUIs) in the Milwaukee Estuary AOC. Due to the complexity of the AOC, some targets, specifically those for Degraded Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat, were left more general, until additional assessments were underway or completed. The purpose of this plan is to address the targets for these two impairments by identifying which assessments and actions are necessary in order for impairment removal to occur.

In 2012, DNR assembled a fish and wildlife technical team to assist in the identification of necessary habitat and population assessments, goals, and actions for the AOC so that BUI removal may eventually occur (Appendix A). This Draft Fish and Wildlife Plan, therefore, draws on the work of the technical team by beginning to fill in some of those gaps. The overarching aim of this planning effort, in concert with the annual Remedial Action Plan Update for the Milwaukee Estuary, is quantifiable and authentic ecosystem improvement, so that (contingent on available funding) these impairments can be ultimately removed from the AOC in a timely and scientifically defensible manner. Completing the assessments in an expedient manner is a first and important step in making necessary progress toward addressing and removing these impairments.

With regard to the RAP or AOC program, this document is essentially an addendum to the Remedial Action Plan (RAP) Update for the Milwaukee Estuary AOC. RAPs are described in the 1987 Protocol amending the *Revised Great Lakes Water Quality Agreement of 1978* as plans that evaluate and describe remedial measures needed to restore the beneficial uses. The Protocol indicates that the RAP should also contain a schedule and identify the organization responsible for implementation. To the extent possible, this plan will show this information for assessments, goals, and actions identified, but will be updated annually as needed to reflect technical team progress. This plan should be treated as a work-in-progress until the assessments are completed and until all remedial actions have been identified.

This fish and wildlife plan focuses on specific issues that are directly responsible for causing impairments locally within the AOC. It reiterates that the goal of the AOC program is to remove beneficial use impairments, not to create a pristine habitat reflective of pre-European settlement conditions. However, the implementation of this plan, and subsequent removal of the fish and wildlife BUIs, can be an important initial milestone toward a broader and more ambitious restoration effort, should the community choose to strive for improvements beyond delisting.

A Word about Citizens' Advisory & Technical Advisory Committees

Citizens' and technical advisory committees are ubiquitous in the RAP program. In the Milwaukee Estuary AOC, we have a wide variety of expertise and stakeholders whose advice may be sought, depending on the particular geographic area of interest and the topic. Because of the focus of this plan, we assembled an ad hoc fish and wildlife technical team to assist in the development of this plan. In essence, they are the technical advisory committee for fish- and wildlife-related issues in the AOC.

On behalf of the more than 250 self-identified stakeholders, a 12-person Stakeholder Delegation was assembled to serve as an outreach advisory panel. The Stakeholder Delegation functions as the

Citizens' Advisory Committee for the AOC; however, broader or targeted participation from the stakeholders may also be desirable or necessary in certain circumstances.

CAUSES OF FISH & WILDLIFE HABITAT AND POPULATION IMPAIRMENTS

According to documents cited in SEWRPC's Memorandum Report Number 194, early records reveal that the Milwaukee Estuary area, including the Milwaukee, Menomonee, and Kinnickinnic Rivers, has been substantially channelized, relocated, dredged, filled, and dammed to convert the significant wetland complex into the highly constructed navigable port that currently exists. This conversion allowed for the development and growth of the greater Milwaukee metropolitan area that currently exists, but this conversion has led to significant environmental degradation in water quality, fisheries, and wildlife habitat. Further comparison of the earliest known survey of the entire Menomonee River and Kinnickinnic River systems completed in 1836 to the present channel conditions in 2005 also shows evidence of significant channelization and diversion of stream channels over this time period (SEWRPC, 2010a, p. 17).

The 1994 RAP recognized these as being a primary reason for listing the Degraded Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat as impaired for the AOC. This section summarizes relevant portions of the 1994 RAP document to provide historical context (WDNR, 1994). Where this information is still relevant, it will be used to help inform the strategy for addressing the impairment.

Degraded Fish and Wildlife Populations

The 1994 RAP states that overall fish species diversity in the AOC was low, with many pollution tolerant species. The lack of natural features in the AOC along with the installation of steel sheet piling, channelization and concrete lining, urban and rural runoff, and high sediment load led to poor quality habitat for fish foraging and spawning. The 1994 RAP also mentions the barrier to fish passage that the former North Avenue Dam provided.

The RAP also specifies that declines in wildlife populations and decreases in species diversity could be partially attributed to urban development in the AOC. Nearly all the wetlands that existed prior to European settlement were filled as development occurred. The RAP cited that the wildlife habitat that remained was concentrated in and around existing parkland and other open areas. It also stated that further investigations were needed to determine whether problems related to poor water quality or toxic contamination impair wildlife populations, since those were suspected as having some kind of an effect (WDNR, 1994, p. 2-17 to p. 2-18).

Loss of Fish and Wildlife Habitat

Urban development is cited as having diminished aquatic and wildlife habitat. The lack of natural areas in the harbor and along the rivers (in the original AOC boundaries) is also identified as part of the impairment, especially for wildlife. The RAP also mentions poor water quality from excessive nutrients and contaminated sediments as degrading habitat for fish. The document states further that although water quality concerns were an issue, this impairment was listed for wildlife because of the lack of physical habitat in the AOC (WDNR, 1994, p. 2-12).

Summary

Overall, the Loss of Fish and Wildlife Habitat and Degraded Fish and Wildlife Populations were listed for the AOC primarily because of

- Poor water quality as a result of changes in land use and increased urbanization,
- Concerns about toxicity from contaminated sediment, and
- The loss of physical and biological habitat from habitat fragmentation and alteration (as a result of urbanization and barriers to fish and wildlife passage), and the lack of natural areas in the AOC.

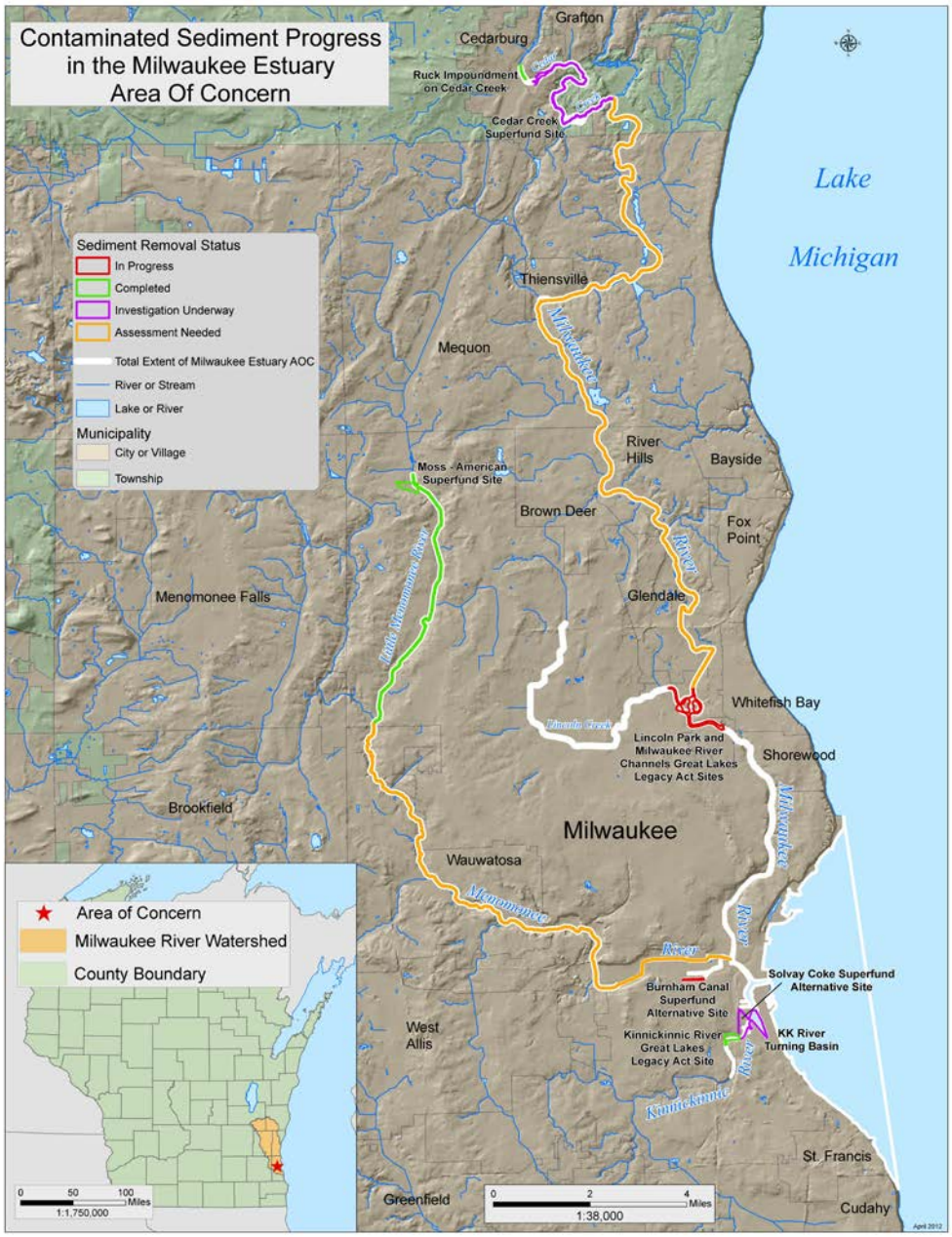

Figure 1. Sediment progress and sites needing action in the Milwaukee Estuary AOC.

Comment [MCO2]: Figure will be updated for final 2013 version.

STRATEGIES FOR ADDRESSING THE FISH AND WILDLIFE HABITAT AND POPULATION IMPAIRMENTS

Degraded Fish and Wildlife Populations

One of the main aspects that still needs to be addressed for this impairment is making progress on contaminated sediments (see Figure 1). This must occur before the impairments can be removed, however, aspects related to contaminants will be addressed primarily through the Restrictions on Dredging and Degradation of Benthos impairments. Additionally, improving water quality is required for this impairment; aspects related to water quality will be addressed primarily through the Eutrophication and Undesirable Algae impairment.

For this impairment, in particular, the Milwaukee Estuary Fish and Wildlife Technical Team has identified necessary assessments to determine the current status of the impairment. These assessments will also assist with target refinement, which is included in both proposals (although the degree of target refinement differs between the two). They will be used to determine, if population targets have not been met, whether additional species-specific management actions are needed so that impairment removal can occur.

Due to the differences in the amount of information that is available for fish and wildlife in the AOC, there are two approaches for assessing fish and wildlife in the AOC. Those approaches are outlined in the assessment proposals that can be found in Appendix A of the 2012 RAP Update for the Milwaukee Estuary. It is worth noting that at the time of AOC designation, there was a poor understanding of the condition of wildlife populations in the AOC. As a result, part of the assessment includes sifting through historical information in order to determine appropriate wildlife population targets and focal species[1]. DNR completed an assessment for fish in the estuary in 1983. Based on this data and improvements since that time, targets for fish species are included in the assessment proposal, and require:

- A 100% increase of relative density for four native indicator species (lake sturgeon, northern pike, walleye, and greater redhorse), and
- An increase in relative density of 95% of the other native species captured in the original 1983 study, regardless of magnitude, and
- An overall mean value from all IBI sampling efforts of “fair” or better (i.e., IBI scores of 40-69).

The assessments for both fish and wildlife are planned to take three years, and call for $565,000 total over the three years. At this point, we are planning to do this work through contracting with outside firms or agencies, although it would also be acceptable to collect the data for the assessments internally, if that capacity exists.

Loss of Fish and Wildlife Habitat

Like the Degraded Fish and Wildlife Populations impairment, making progress on contaminated sediments must occur before the impairment can be removed. However, aspects related to contaminants will be addressed primarily through the Restrictions on Dredging and Degradation of Benthos impairments. Additionally, improving water quality is required for this impairment; aspects related to water quality will be addressed primarily through the Eutrophication and Undesirable Algae impairment.

[1] Focal species can be defined as those whose habitat requirements represent those of a larger species suite. These habitat requirements are then utilized in developing restoration projects which can support these species. Focal species must have habitats that can be realistically restored or enhanced in the project area (i.e., the AOC), and may include keystone, umbrella, or flagship species.

The way this impairment will be specifically addressed is by implementing habitat projects that the fish and wildlife technical team identifies. While not all habitat projects have been identified at this time, the fish and wildlife technical team was able to identify a list of interim habitat projects. These habitat projects are derived from the interim habitat goals, each of which addresses several critical aspects of physical or biological habitat in the AOC. We will continue working with stakeholders to finalize goals and measures of success that are desirable and achievable for this impairment. For a complete listing of the goals and potential measures of success used to develop the interim habitat goals and help the group focus on priority habitat projects, see Appendix B.

Habitat Project Criteria

Each of the interim habitat projects addresses at least one of the habitat goals, and also meets the key practical criteria listed below. Additionally, for each goal, appropriate measures of success are also listed for each project to help measure progress toward removing the impairment. Besides addressing necessary technical criteria for habitat projects, there were also some practical features that were necessary in order for a potential project to be included. Candidates for interim physical habitat projects are listed here because they generally met several key practical criteria:

- They have a discrete area/geographic location associated with them,
- They have a cooperative landowner (typically public ownership),
- And they have a willing and interested implementer to spearhead the work,
- By helping to accomplish at least one of the physical/biological habitat goals, they would substantively help improve physical/biological habitat in the AOC. The interim habitat goals are listed and explained in further detail below.

  Physical/biological habitat primary goals:

  1. Enhance/improve aquatic habitat.
     a. Identify and enhance fish spawning sites from Lake Michigan to the tributaries and headwaters where opportunities exist (e.g., Inner and Outer Harbors, Milwaukee River downstream of the North Ave. Dam pedestrian bridge).
     b. Insert value-added habitat projects where possible with Kinnickinnic River Concrete Removal.
  2. Improve aquatic habitat connectivity.
     a. Improve linear connectivity by restoring or enhancing fish and aquatic organism passage from Lake Michigan to the tributaries and headwaters.
     b. Improve lateral connectivity by connecting aquatic habitat to floodplain wetland with suitable hydroperiod, whenever possible.
     c. Reconnect high quality habitat downstream of the Bridge Street Dam and Lepper Dam to the main stem rivers of the AOC.
  3. Enhance/improve terrestrial, semi-aquatic, and/or riparian habitat.
     a. Expand habitat buffer width to a minimum of 75 feet.
     b. Where possible, expand shoreline buffers up to 1,000 feet to meet core habitat area needs for semi-aquatic species.
     c. Expand and improve habitat for species identified as of local conservation interest (typically rare, keystone, or other focal species).
     d. Construct ephemeral wetlands where feasible and where optimally beneficial, addressing target species' critical habitat needs (TBD through wildlife assessment), relevant biological and human constraints, and with metrics for monitoring success (i.e., increases in species richness on a landscape).

e. Identify and enhance existing and potentially restorable habitat areas through fish and wildlife assessments, whenever possible. (For portions of the Little Menomonee and Milwaukee Rivers, this process is already underway from a 2011 LMR wildlife habitat assessment and an ongoing MR Greenway assessment.)

4. Improve terrestrial riparian habitat connectivity.
    a. Expand riparian buffer habitat quality and continuity.
5. Protect high-quality areas or environmentally sensitive lands, especially those supporting rare and protected species.

Physical/biological habitat secondary goals

1. Moderate flow regimes to decrease flashiness.
2. Provide and preserve sufficient baseflow.

Primary habitat goal explanations

In order to provide some context for why each of the habitat goals, and meeting those goals, is critical, an explanation is provided for each of the goals and, where applicable, related objectives. Many of the goals and explanations are taken directly from SEWRPC's Biological Assessment for the Menomonee and Kinnickinnic Rivers that was completed in 2010, and are relevant to other impacted waters in the Milwaukee Estuary AOC.

In-stream goal: **Enhance/improve aquatic habitat.**

Why is enhancing/improving aquatic habitat necessary to delist the AOC?

Stream channels in the AOC have been highly altered in many locations, whether through installation of sheet piling, channelization/concrete lining, dredging, damming, or other in-stream changes that have occurred as a result of urban-influenced hydrology (changes in sediment loads, substrate type, channel incision, etc.). Prior to all these alterations, fish and other aquatic life had access to deep near-shore habitat, thousands of acres of shallower wetland habitat with abundant and diverse submergent and emergent aquatic plant communities, and hundreds of miles of riverine habitat. These varied and connected habitat types provided fish and other aquatic organisms (i.e., mussels, turtles) with their critical reproductive, protective, and growth (feeding) life requisites. At the time of AOC designation, nearly all of these critical habitat types had been obliterated from the estuary. Deep water and near-shore Lake Michigan habitats (currently comprised of the Inner and Outer Harbors) and nearly all associated wetlands were altered and/or destroyed. As a consequence, fish and other aquatic organisms' populations have dwindled as a direct result of alterations within the AOC. Therefore, to improve their populations, it is critical to try to address these alterations as opportunities present themselves. Several projects of varying scales have already occurred within the AOC and further upstream in its tributaries, including the removal of multiple dams (the Menomonee River Falk Dam, the Milwaukee River North Avenue, Lime Kiln and Chair Factory Dams, the Pigeon Creek Wisconsin Lutheran Seminary Dam), the construction of an engineered fish passage facility (Milwaukee River Thiensville Dam fishway), the removal of several miles of concrete lined stream channels (Kinnickinnic River, Menomonee River, Lincoln and Indian Creeks), the removal or replacement of over 40 barrier culverts, and rehabilitating wetlands (Trinity Creek). Despite these improvements, there is additional work to be done in the AOC that would improve aquatic habitat and aid in providing aquatic life with habitat types that would meet their critical reproductive, protective, and growth (feeding) life requisites.

What opportunities exist to accomplish this goal?

There are several types of activities that can be done to help alleviate the impacts of these hydrological alterations that have also affected habitat in the AOC.

- *Improving opportunities for fish spawning habitat in the inner and outer harbor.* Because of their close connection to Lake Michigan, increasing the extent of wetland habitats for phytophilic spawning fishes, and increasing the diversity and extent of native aquatic plants in deep water habitats for protection and growth (feeding) of native adult and juvenile fish, and enhancement of spawning habitat for lithophilic spawning fishes is a priority. Due to social, economic, and technical constraints within most of the estuary, however, efforts to enhance near-shore Lake Michigan and estuary AOC fish populations, in particular migratory potamodromous and fluvial species, must include the removal of significant barriers to riverine and wetland spawning habitats, as well as creating or enhancing the biological functions of riverine and wetland habitats where they are found to be technically, socially, and economically feasible.

- *Insert value-added habitat projects where possible with Kinnickinnic River Concrete Removal.* As noted above, opportunities to do aquatic-based habitat projects within the AOC may be limited, given social, economic, and technical constraints. The Kinnickinnic River, the most urban of the AOC rivers, has become exceptionally degraded from hydrologic alterations listed above, with most of the river either sheet piled or lined in concrete. There are, however, long-term plans by the MMSD to remove most of the concrete, and several projects have already occurred to remove portions of concrete downstream of the 6th St. Bridge on Milwaukee's south side. Because opportunities are especially limited on the Kinnickinnic River for habitat improvement, we would like to see that whenever concrete is removed, additional value is added to the project by including additional design components that would add overall value to the project. These projects are commissioned primarily to reduce safety issues, but they also provide opportunities to improve habitat.

- *Reconnect high quality habitat downstream of the Bridge Street Dam (Milwaukee River) and Lepper Dam (Menomonee River) to the main stem rivers of the AOC.*
We realize the necessity of creating a certain amount of high quality habitat that is connected to the AOC, if fish populations are going to be able to address their critical reproductive, protective, and growth (feeding) life needs. Due to the urban nature of the AOC and its surrounding areas, there are limitations on what can be done to improve conditions for fish and wildlife within the AOC. While we are striving to improve aquatic habitat connectivity overall (see next goal explanation), we also recognize that the high quality habitat that is necessary for certain species may not be able to successfully created within the boundaries of the AOC. In support of this goal, efforts to remove fish movement barriers (see below), and create or enhance critical habitats will extend to the designated complete aquatic invasive species barriers at the Menomonee River Lepper Dam located 17-river miles (RM 17) at Menomonee Falls and select tributaries; and the Milwaukee River Bridge Street Dam located 32-river miles (RM 32) at Grafton, and select tributaries.

Comment [MCO3]: Is this really something that would have to be done in order to remove the impairment?

In summary, projects that help mitigate the extensive alterations that occurred in the AOC can have a real and measurable positive impact in the AOC. Such was the case with the removal of the North Avenue Dam and the in-stream habitat enhancements that were also installed around the time of the dam removal. Furthermore, this goal is tightly linked with the next goal, since opportunities in the AOC will be limited for improvement, but ensuring that fish can access other high quality habitats will help bolster overall populations.

In-stream goal: **Improve aquatic habitat connectivity.**

Why is improving aquatic habitat connectivity necessary to delist the AOC?
Removing barriers to fish and aquatic organism movement cannot be overstated. This is especially true in the AOC, where the shoreline has been highly altered in most locations, and while some improvements can and should be made that would improve in-stream aquatic habitat, providing passage to upstream areas with higher quality habitat is essential. The Southeastern Wisconsin

Regional Planning Commission (SEWRPC) has recommended using a three-tiered approach for prioritizing in-stream management actions for linear connectivity (Memorandum Report No. 194, pp. 38-41). This framework is focused on the reconnection of waterways that have been historically isolated from the Lake Michigan stream system through construction of dams, roadways, and flow control structures, or modified through construction of single-purpose systems, such as stormwater conveyances.
The three components of this strategy are:

- Tier 1–Restoring connectivity and habitat quality between the mainstem waterways and the Lake Michigan endpoint,
- Tier 2–Restoring connectivity and habitat quality between the tributary streams and the mainstems of the Milwaukee, Menomonee, and Kinnickinnic Rivers, and
- Tier 3–Expanding connection of highest-quality fish, invertebrate, and habitat sites within each of the watersheds.

The third tier is a "catch-all" that enables stakeholders to link the goals of habitat restoration and improvement of recreational options with ongoing activities throughout each watershed. This strategic element provides the flexibility for communities and stakeholders to take advantage of opportunities throughout each watershed that may arise independently of the primary strategy of restoring linkages with Lake Michigan and tributary streams. An example of this latter strategic approach would be using the opportunity provided by scheduled reconstruction of area roadways to remove obstructions or modify channelized stream segments that might not fully conform to the first two strategic priorities. To this end, it is further noted that provision of fish passage will provide passage for other aquatic organisms such as invertebrates.

It is fully recognized that within this framework opportunities will arise that should be acted upon. For example, even though it is a general principle of this strategy that activities progress from downstream to upstream, the completion of an action in headwaters areas or on a tributary stream should not be passed up or ignored simply because it does not conform to the downstream to upstream strategy. Rather, all opportunities should be seized as they become available. However, where multiple opportunities exist, and where limited funds are available, this strategic framework is intended to assist decision-makers in allocating resources where they would be most appropriate and effective in achieving the goals of the regional water quality management plan update. Figure 2 on the following page shows an example of how this prioritization strategy works.

For improving lateral connectivity, enhancing connections of floodplains to their respective channels would also provide additional habitat enhancements, especially for species like northern pike, which prefer shallow, grassy areas for spawning.

What opportunities exist to accomplish this goal?

Removal of barriers on the AOC tributaries, starting with the downstream/mainstem barriers whenever possible, is necessary, and we know of several opportunities (see project list). Additionally, we will also look into a strategy to prioritize which potential fish passage projects in the higher quality portions of the AOC would yield the best results for fish populations.

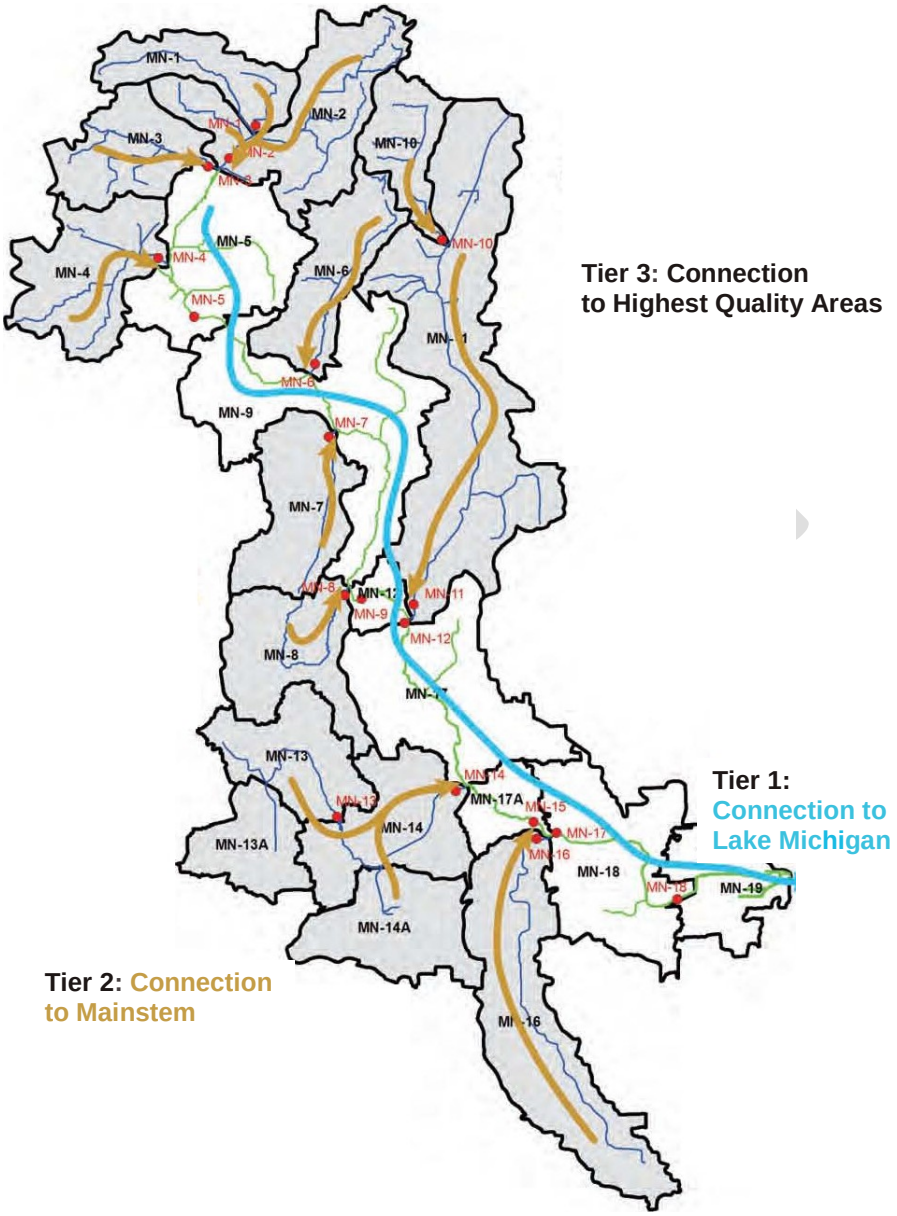

Figure 2. An example of the in-stream three-tier prioritization strategy within the Menomonee River Watershed. (Figure Adapted from SEWRPC, 2010a.)

Riparian goal: **Enhance/improve terrestrial, semi-aquatic, and/or riparian habitat.**

Why is improving terrestrial, semi-aquatic, and/or riparian habitat necessary to delist the AOC?

Wildlife habitat in the AOC has been highly altered through a variety of impacts. Urban development has greatly reduced the acreage available for wildlife habitat. Remaining habitat patches are often small and isolated, reducing their suitability for wildlife species that require large habitat patches. Connectivity of habitats has been fragmented by roads and developments. Habitat quality and its suitability for supporting viable wildlife populations has been degraded through the spread of non-native invasive plant species, a super abundance of human-subsidized predators (i.e., raccoons, opossums), and contaminants from a variety of sources (e.g., airborne, industrial waste, urban runoff). Excessive noise levels and urban lighting can also alter wildlife behaviors, reduce reproductive success, increase exposure to predation, and elevate stress levels with subsequent reductions in fitness (Andrews et al., 2006).

Prior to all these alterations, wildlife had access to thousands of acres of diverse, quality habitats directly connected to the AOC, including aquatic, wetland, riparian and terrestrial habitats. Habitats such as mature forest, bluffs, vernal ponds, tamarack swamps, and emergent marsh supported wildlife species that had very specialized habitat requirements. These connected habitat types provided the critical reproductive, protective, and growth (feeding) life requisites. At the time of AOC designation, most of these critical habitat types had been substantially lost or degraded, and could no longer support many wildlife species. For example, estimates of species richness losses for the county are 37% for breeding birds, 47% for reptiles, and 44% for amphibians, along with a 37% loss of the native flora in the habitats of these species (Casper. 2008; Leitner *et al.,* 2008). Losses within the more limited AOC area are undoubtedly higher. For example, a review of mussels in the Greenway section of the AOC (the Milwaukee River from the Milwaukee/Ozaukee County line downstream to Humboldt Ave.) suggests that somewhere between 27% and 57% of species have been lost (Casper and Dare, 2013). Lichens, an important component of wildlife habitat, are especially sensitive to air pollution (Brodo *et al.,* 2001) and a trend towards higher species richness with distance from roads was suggested in a recent study within the AOC (Rutherford, 2012). This loss of species richness, and reduction of wildlife abundance, is a direct result of habitat alterations within the AOC.

To improve wildlife habitat and populations, it is critical to address existing habitat alterations as opportunities present themselves. A first step is underway, an assessment of current conditions and evaluation of which species can be reasonably targeted for restoration. Since it will be impossible and undesirable to restore wildlife resembling pre-settlement conditions in an area dominated by economic development priorities, the assessment will identify a suite of native wildlife species that can be restored to sustainable populations within these social constraints. For example, some simple habitat restorations such as restoring vernal pools within managed terrestrial or riparian habitat matrices can significantly increase the number of species supported, restoring those that require vernal pools as a critical breeding habitat (such as many salamanders and frogs, aquatic insects, fairy shrimp and dabbling ducks). Similarly, connecting and expanding existing forest stands can result in increased richness and abundance of forest interior species such as woodpeckers, tree squirrels, owls, and songbirds. Several projects of varying scales have already occurred within the AOC and further upstream in its tributaries, such as the restoration of vernal ponds at the Mequon Nature Center, and planning for others has begun through organizations such as the Milwaukee River Greenway Coalition, and Milwaukee County Parks. Riparian buffer recommendations have been advanced by SEWRPC that enhance habitat along streams. Despite these efforts, no comprehensive AOC-wide plan has been completed, identifying the species of local conservation interest and targeting specific on-the-ground habitat improvements to address the BUIs. Completing the AOC-wide wildlife assessments and project recommendations will address the need for providing wildlife with habitat improvements that meet their critical reproductive, protective, and growth (feeding) life requisites.

To summarize, buffers and connectivity are an important starting point for restoring wildlife habitat (and eventually wildlife populations), but more work through the wildlife assessment will also be necessary to help better define how to have riparian, terrestrial, and semi-aquatic habitat that not only affords water quality benefits, but is also truly functional as habitat for select focal species in the AOC.

What opportunities exist to accomplish this goal?
Many opportunities exist within public and private lands to improve and restore wildlife habitats. Many of these goals overlap with water quality goals, and achieving partnerships that accomplish multiple goals is a high priority in the AOC, where social constraints and competing land use interests somewhat limit opportunities for habitat restorations. Specific examples include:

- *Expand habitat buffer width to a minimum of 75 feet.*
  The SEWRPC has identified the Rule of 75: 75% is the proposed minimum of total stream length that should be naturally vegetated to protect the functional integrity of the water resources, and 75 feet is the proposed minimum riparian buffers width from the top edge of each stream bank should be naturally vegetated to protect water quality and wildlife (SEWRPC, 2007). For the purposes of the AOC, 75 feet has been recommended as the objective for riparian restoration projects in the AOC, in order to provide water quality benefits and also for its potential to provide wildlife habitat.
- *Where possible, expand shoreline buffers up to 1,000 feet to meet core habitat area needs for semi-aquatic species.*
  There are many riparian buffer functions and the ability to effectively fulfill those functions is largely dependent on width. Determining what buffer widths are needed should be based on what functions are desired as well as site conditions. For example, water temperature protection generally does not require as wide a buffer as provision of habitat for wildlife. Based on the needs of wildlife species found in Wisconsin, the minimum core habitat buffer width is about 400 feet and the optimal width for sustaining the majority of wildlife species is about 900 feet. This recommendation from SEWRPC is data reported in the scientific literature and the quality of available habitats within the context of those studies. Additionally, buffer size drives important natural functions like food availability and quality, access to water, habitat variety, protection from predators, reproductive or resting areas, corridors to safely move when necessary, and help in maintaining the health of species' gene pools to prevent isolation and perhaps extinction (SEWRPC, 2010, p. 10).
- *Expand and improve habitat for species identified as of local conservation interest (typically rare, keystone, or other focal species).*
  Many taxonomic groups have already demonstrated lost species richness in the area, which offers excellent restoration opportunities. The species of local conservation interest approach provides a method to identify what is actually important and feasible, and then is used to help recommend more species-specific goals, given that there are potentially thousands of "native" or "exotic invasive" species in the AOC. This approach also addresses species' critical habitat needs. For example, while improving buffers and connections is an important first step, amphibians species that have largely been extirpated from the area, will need additional and specific types of habitat, like breeding sites, if their populations are to be successfully re-established. Like fish, wildlife will need to have their critical habitat parameters met if restoration plans are to be truly successful and sustainable in the longer-term.
- *Construct ephemeral wetlands where feasible and where optimally beneficial.*
  Based on work already done in the area, we know that doing this will address some of the target species' critical habitat needs (TBD through wildlife assessment). Relevant biological and human constraints will be addressed in any proposals for ephemeral wetland construction along with metrics for monitoring success (i.e., increases in species richness on a landscape) (See Appendix C).
- *Identify and enhance existing and potentially restorable habitat areas through fish and wildlife assessments, whenever possible.*

For portions of the Little Menomonee and Milwaukee Rivers, this process is already underway from a 2011 LMR wildlife habitat assessment and an ongoing MR Greenway assessment.

Terrestrial goal: **Improve terrestrial riparian habitat connectivity.**

Why is improving terrestrial riparian habitat connectivity necessary to delist the AOC?

In the AOC, urban and suburban land uses fragment the landscape by creating islands or isolated pockets of wetland, woodland, and other natural lands available for wildlife preservation and recreation. One major factor responsible for this decline in diversity is that routes for native plants and wildlife to re-colonize isolated habitat islands are largely cut-off within the fragmented landscapes. Fragmentation of the landscape has resulted in decreased biological diversity, but can be mitigated.

The ability of in-stream and riparian habitat to support wildlife is directly limited by adjacent terrestrial and semi-terrestrial habitat quality, through a variety of connections. These connections include water quality issues (the ability of watershed habitats to filter, absorb, and release rain water and runoff), and wildlife habitat issues related to the biological constraints each species is bound by that cannot be altered. Biological constraints are not "negotiable," being set by evolution and the physical limits of the species (Dodd and Seigel, 1991; Seigel and Dodd, 2000; Dodd, 2001). They include parameters such as the presence of critical habitats like denning sites or nesting areas; the quality of habitats including aquatic, wetland, and terrestrial habitat needs of the species; and minimum viable habitat patch size. Habitats adjacent and/or connected to aquatic or riparian areas are part of the biological constraint of patch size which limits the species supported in the entire habitat area, and restoring losses of wildlife habitat and populations cannot be achieved unless all available connected habitat is considered. According to SEWRPC, "Emerging research has increasingly shown that, in addition to water, more and more species such as amphibians and reptiles cannot persist without landscape connectivity between quality wetland and upland habitats. Good connectivity to upland terrestrial habitats is essential for the persistence of healthy sustainable populations, because these areas provide vital feeding, overwintering, and nesting habitats found nowhere else. Therefore, both aquatic and terrestrial habitats are essential for the preservation of biodiversity and they should ideally be managed together as a unit" (SEWRPC, 2010, p.12).

Comment [MCO4]: Format quote correctly for final version.

Habitat patch size and connectivity are important biological constraints on wildlife presence and abundance. Increasing connectivity among quality natural landscapes (wetlands, woodlands, prairies) can benefit biodiversity by providing access to other areas of habitat, increasing gene flow and population viability, enabling recolonization of patches, and providing habitat (Bentrup, 2008 in SEWRPC, 2010, p.12).

In short, larger and more diverse habitats support more species and greater wildlife abundance. The wildlife assessment will determine a balance between available area for habitat restoration and enhancement, and the number of species and species abundance that can be expected to result. A feasible target for species richness and abundance can then be set as a delisting goal, which is acceptable within the social and biological constraints of the system. For example, a 50% increase in amphibian species may be set as a goal, based on an assessment that concludes that creating 20 new vernal ponds and enhancing the habitat around them should achieve this result. Similar goals for increasing mammal, bird and invertebrate populations can be set, with metrics and methods for monitoring to demonstrate success.

What opportunities exist to accomplish this goal?

- *Expand riparian buffer habitat quality and continuity.*

Several partners have lands or other interests that are directly aligned with this goal, where such projects could be potential implemented, including the Milwaukee River Greenway Coalition/River Revitalization Foundation, Urban Ecology Center, Milwaukee County Parks, and MMSD through its Greenseams program.

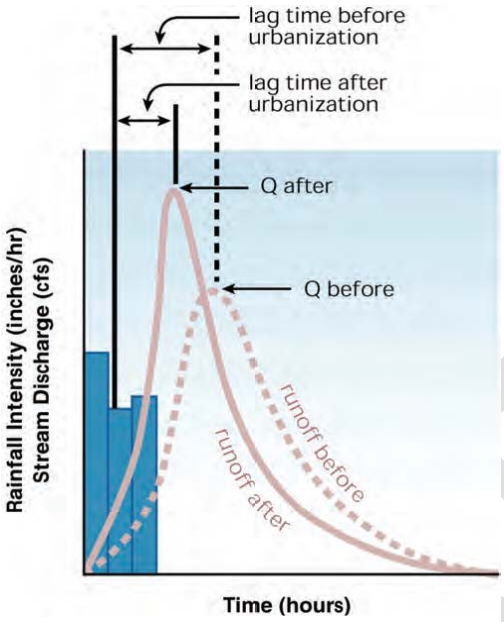

Figure 3. Urbanization and interconnected impervious surfaces result in "flashy" streams, where stream discharge surges relatively quickly after a precipitation event.

Terrestrial goal: **Protect high-quality areas or environmentally sensitive lands, especially those supporting rare and protected species.**

Why is protecting high-quality areas or environmentally sensitive lands, especially those supporting rare and protected species, necessary to delist the AOC?
High-quality and sensitive lands provide specialized wildlife habitats that support vastly greater species richness. The loss of these specialists was the first extinction cascade in the AOC (Leitner *et al.*, 2008), so that we now see an excess of generalist species. Protecting, restoring and enhancing these habitats is the most productive and efficient way to restore species richness in the AOC. Identifying existing populations of rare and protected species is important and necessary to preventing further losses of species. These species are by definition rare and need to be preserved and enhanced. It is also important to identify their habitats to follow a "first do no harm" paradigm, such that related projects do not further degrade or eliminate these rare populations without appropriate mitigation to prevent losses.

What opportunities exist to accomplish this goal?
Several partners have lands, or other interests, that are directly aligned with this goal, where such projects could be potential implemented, including the Milwaukee River Greenway Coalition, Milwaukee County Parks, and MMSD through its Greenseams program.

Secondary habitat goal explanations

Goal: **Moderate flow regimes to decrease flashiness.**

Why is moderating flow regimes necessary to delist the AOC?
According to the SEWRPC Memorandum Report No. 194, urbanization itself is not the main factor driving the degradation of the local waterbodies. Streams can survive and flourish in urban settings. The main factors leading to the degradation of urban waterbodies are the creation of large areas of connected impervious surfaces, the lack of adequate stormwater management facilities to control the quantity and quality of runoff, proximity of development to waterbodies, loss of natural areas, and inadequate construction erosion controls. These factors increase the potential for the occurrence of the negative water quality/quantity effects associated with urbanization.

In the absence of mitigating measures, urbanization impacts the watershed, not only by altering the ratio between stormwater runoff and groundwater recharge, but also through the changing of stream hydrology (i.e., increasing stormwater runoff volumes and peak flows and altering the baseflow regime) and through divergence of the seasonal thermal regimes away from their historical patterns (see Figure 3). These changes further influence other characteristics of the stream, such as channel morphology, water quality/quantity, and biological diversity. More specifically, recent research has shown that average flow magnitude, high flow magnitude, high flow event frequency, high flow duration, and rate of change of stream cross-sectional area were the hydrological variables most consistently associated with changes in algal, invertebrate, and fish communities (pp. 9-10).

Location of impervious surfaces also determines the degree of direct impact they will have upon a stream. There is a greater impact from impervious surfaces located closer to a stream, due to the fact that there is less time and distance for the polluted runoff to be naturally treated before entering the stream. A study of 47 watersheds in southeastern Wisconsin found that one acre of impervious surface located near a stream could have the same negative effect on aquatic communities as 10 acres of impervious surface located further away from the stream (p. 15).

Urbanization increases impervious surface, which can lead to an increase in “flashiness” (or the rate at which flow responds to a precipitation event). Such increases in streamflow subsequently affect streambank stability, streambed stability, pollutant loading, and sediment dynamics, which, in turn, affect habitat availability and quality (p. 17).

Goal: **Provide and preserve sufficient baseflow.**

Why is providing and preserving sufficient baseflow necessary to delist the AOC?
As stated in the SEWRPC Memorandum Report. No. 194, in the absence of mitigating measures, one of the consequences of urban development is the increase in the amount of stormwater, which runs off the land, instead of infiltrating into the groundwater. A parking lot or driveway produces much more runoff than an undisturbed meadow or agricultural hay field. Depending on the degree of watershed impervious cover, the annual volume of storm water runoff can increase by up to 16 times that for natural areas. In addition, since impervious cover prevents rainfall from infiltrating into the soil, less flow is available to recharge groundwater. Therefore, during extended periods without rainfall, baseflow levels are often reduced in urban streams. This has been observed to occur in both the Menomonee and Kinnickinnic River watersheds. Furthermore, runoff traveling over a parking lot or driveway will pick up more heavy metals, hydrocarbons, chlorides, bacteria, pathogens, and other stream pollutants than runoff traveling over surfaces that allow some of the stormwater to be filtered or to infiltrate. Runoff traveling over impervious surfaces bypasses the filtering action of the soil particles, soil microbes, and vegetation present above (stems and leaves) and below (roots) the soil surface. For example, MMSD staff observed that total phosphorus and total suspended solids concentrations downstream of stormwater outfalls in the greater Milwaukee River watersheds were significantly higher during the initial first flush of a rainfall event compared to later samples (p. 12).

In the Menomonee River watershed, the highest amount of agricultural and open lands are located in the northern portion of the watershed, and these areas are currently providing the greatest amount of groundwater infiltration, helping to sustain stream baseflows. The developed areas within the watershed are associated with the lowest groundwater recharge potential. Therefore, preservation and, where feasible, expansion of the open space lands including agricultural lands would protect, and perhaps enhance, the groundwater recharge potential within the watershed (p. 24).

HABITAT PROJECT LIST

Listed below are the projects that will address the Loss of Fish and Wildlife Habitat impairment for the Milwaukee Estuary. As stated earlier, this impairment cannot be removed without addressing contaminated sediments. Additionally, we reserve the right to require additional habitat enhancement/creation actions, pending the results of the fish and wildlife population assessments. Those actions, however, would be necessary for removal of the Degraded Fish and Wildlife Populations impairment.

The "ready to go" list of projects meet both practical and technical aspects of the habitat goals. The technical team identified some other projects that would also address the fish and wildlife habitat impairment, but some of these projects, at this time, have no project implementer, and/or need further design or engineering work so that cost estimates are available. We hope that further funding opportunities are available to help assist in project development.

The following projects are "shovel ready" and should be implemented, in 2014, as they have been identified as being necessary for BUI removal, including:

- [insert project name and cost]
- **Total funds required for 2014 projects = $**

In 2013, several projects were funded that had to be implemented for BUI removal, including:

- Wheelhouse Gateway Riparian Restoration- ~$500,000
- Removal of Five Low-Flow Barriers on the Menomonee River- ~$900,000
- Little Menomonee River Parkway Grassland Restoration (Phases 1 and 2)-$40,000
- Menomonee River Concrete Removal (from Wisconsin Ave. to I-94)-$3,000,000
- **Total funded for 2013 = $4,440,000**

Comment [MCO5]: List of projects for 2014 priority will not be available until after public comment period closes. For questions/suggestions, please e-mail Megan.

CONCLUSION

Work is underway in the AOC to help constrain final targets (i.e., project specific targets and target species to rehabilitate) for the fish and wildlife impairments. It should be noted that the causes attributed to the loss of habitat may not be able to be sufficiently addressed by implementing projects only within the original boundaries of the AOC. This is especially true in the case of wildlife, but can also be applied to the availability of aquatic passage to high-quality habitat areas for aquatic and semi-aquatic species. As a rule of thumb, our aquatic habitat goals are consistent with the Southeastern Wisconsin Regional Planning Commission's recommendations to prioritize projects.

REFERENCES

Andrews, K. M., J. W. Gibbons, and D. M. Jochimsen. 2006. *Literature synthesis of the effects of roads and vehicles on amphibians and reptiles*. Federal Highway Administration (FHWA), U.S. Department of Transportation, Report No. FHWA-HEP-08-005.

Brodo, I.M., S.D. Sharnoff, and S. Sharnoff. 2001. Lichens of North America. Yale University Press.

Casper, G. S. 2008. *Changes in amphibian and reptile communities*. Chapter 20 in D. Waller and T. Rooney (eds). The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife. The University of Chicago Press.

Casper, G. S., and J. M. Dare. 2013. *Mussels of the Milwaukee River Greenway: A preliminary assessment.* Technical report to the Milwaukee River Greenway Coalition. http://www.milwaukeerivergreenway.org/wp-content/uploads/Greenway-Mussel-Report-final.pdf.

Dodd, C. K. Jr. 2001. North American Box Turtles. A natural history. University of Oklahoma Press.

Dodd, C. K. Jr. and R. A. Seigel. 1991. *Relocation, repatriation, and translocation of amphibians and reptiles: are they conservation strategies that work?* Herpetologica 47(3):336-350.

Leitner, L. A., J. H. Idzikowski, and G. S. Casper. 2008. *Urbanization and ecological change in Milwaukee County*. Chapter 25 in D. Waller and T. Rooney (eds). The Vanishing Present: Wisconsin's Changing Lands, Waters, and Wildlife. The University of Chicago Press.

Rutherford, R. 2012. *Lichens, Odonates, and Butterflies of the Milwaukee River Greenway*. Technical report to the Milwaukee River Greenway Coalition, November 17, 2012.

Seigel, R.A. and C. K. Dodd, Jr. 2000. *Manipulating turtle populations: halfway technologies or viable options?* Pp. 218-38 in M. Klemens (ed). Turtle Conservation: A Blueprint for Survival, Smithsonian Institution Press.

Southeastern Wisconsin Regional Planning Commission. 2007. *A regional water quality management plan for the Greater Milwaukee watersheds*. Planning Report No 50. http://www.sewrpc.org/SEWRPCFiles/Publications/pr/pr-050_part-1_water_quality_plan_for_greater_mke_watersheds.pdf.

Southeastern Wisconsin Regional Planning Commission. 2010a. *Stream habitat conditions and biological assessment of the Kinnickinnic and Menomonee River watersheds: 2000-2009*. Memorandum Report No. 194. http://www.swwtwater.org/home/documents/mr_194_kk_mn_rivers_stream-habitat-biological-assessment.pdf.

Southeastern Wisconsin Regional Planning Commission. 2010b.*Managing the water's edge: Making natural connections.* http://www.sewrpc.org/SEWRPCFiles/Environment/RecentPublications/ManagingtheWatersEdge-brochure.pdf.

APPENDICES

Appendix A Fish and Wildlife Technical Team Roadmap
Appendix B Goals and Measures of Success for Fish and Wildlife for the Milwaukee Estuary AOC

(page left intentionally blank)

Appendix A

Fish and Wildlife Technical Team Roadmap

(page left intentionally blank)

Road Map for Developing a Draft Fish and Wildlife Habitat Plan by December 2012

Membership

Members were invited based on their technical expertise on matters related to fish and wildlife issues. Members typically also represent an agency, organization, or program. Others may attend the technical team meetings if they contact the AOC coordinator before a scheduled meeting. The members for the Milwaukee Estuary Fish and Wildlife Technical Team are listed below along with their areas of expertise and/or agency represented.

Brian Russart (Milwaukee County Parks)
Theresa Morgan (River Revitalization Foundation)
Marty Johnson (DNR-Wildlife)
Cheryl Nenn (SWWT Science Committee/Milwaukee Riverkeeper)
Steve Choy (U.S. Fish and Wildlife Serivce)
Noel Cutright (Birds)
Joanne Kline (DNR-Environmental Analysis/wetlands)
Josh Kapfer (Herptiles)
Dan Sullivan (U.S. Geological Survey/fisheries)
Andrew Struck (Ozaukee County/birds)
Will Wawrzyn (DNR-Fisheries)
John Janssen (UW-M Great Lakes WATER Institute/fisheries)
Chris Magruder (Milwaukee Metropolitan Sewerage District)
Tom Slawski (Southeastern Wisconsin Regional Planning Commission)
Marsha Burzynski (DNR-Water Resources)
John Masterson (DNR-Water Resources)
Andy Fayram (DNR-Office of the Great Lakes)
Ann Brummitt/Gary Casper (Milwaukee Greenway Coalition)

It was originally envisioned that the group would meet approximately quarterly, but the group may decide that they would like to meet more frequently, or more frequently over a certain period of time. Members are charged with reviewing the AOC coordinator's work, and giving input and feedback to help shape a draft plan.

If work is still necessary moving into 2013, members will each have the opportunity to determine whether they wish to continue working on the technical team.

Work Group Charge

Form an ad hoc work group that will assist in the development of a draft fish and wildlife habitat plan that addresses the Milwaukee Estuary AOC delisting targets to have a fish and wildlife plan for the AOC.

What are we trying to accomplish? (Goal)

A strategy that outlines if and what further assessment actions are necessary to define the fish and wildlife impairments, and that outlines the priority actions (i.e., projects) necessary to address the impairments. The group should also decide the appropriate metrics that should be used in order to determine the success of the projects.

Why is it needed? (Objectives)

- To identify which assessments are necessary in order to determine the extent that fish and wildlife populations in the AOC are impaired.
- To provide clarity on the relative priority of potential projects that would be implemented in the AOC.

What should the Fish and Wildlife Plan entail to be effective? (Outcomes)

- Summary of existing biological and habitat data within the AOC and identify what additional monitoring is needed to assess the current conditions.
- Should specify for each potential project who would be responsible for implementing the project.
- Set a clear priority level of which projects must occur for BUI removal ("Tier 1 Projects"), versus projects that are of benefit, but not necessary, for the purposes of BUI removal in the AOC ("Tier 2 Projects").
- Should assess the potential in and merits of habitat improvement the estuary portion of the AOC compared to the expanded boundaries.
- Should address opportunities for collaboration with partners and citizens to fulfill BUI removal.

What specific elements should the Fish and Wildlife Plan include? (Outputs)

- Inventory of existing monitoring needs, and available resources (staffing, funds, etc). May include a list of past projects and reports.
- Direction for technical teams and clarification of roles and responsibilities of AOC staff.
- A process for setting and ranking project priorities, especially priorities for WDNR staff versus other partners.
- Benchmarks and a process for evaluating success at regular intervals.

Timeline:

The goal is to have developed a draft fish and wildlife plan by the end of 2012.

- Initial contact with potential members to occur in Feb. and March.
- Initial meeting planned for May 2012, with tentative additional meetings held quarterly thereafter.
- Draft fish and wildlife plan completed by Dec. 2012.
- In order to achieve the desired outcomes and goals, we will need to answer the following questions at our meetings:
    - What is the exact boundary of the area that we should focus on?
    - Which assessments are still needed to determine the extent of the impairment?
    - How do we determine our list of projects that must occur?
    - What is the list of projects that must occur in order to remove the fish and wildlife habitat and population impairments?
    - Others?

Appendix B

Goals and Measures of Success for Fish and Wildlife for the Milwaukee Estuary AOC

(page left intentionally blank)

Goals and Measures of Success for Fish and Wildlife for the Milwaukee Estuary AOC

I. In-stream-based Measures

A. Fish Habitat Goal: Restore fish and aquatic organism passage from Lake Michigan to the headwaters and tributaries.

- Potential measures of success
  - Stream-miles of concrete removed (habitat)
  - Number of native species present or some equivalent biological indicator (e.g, native species richness, Index of Biotic Integrity, etc.) (populations)
  - Number of impediments removed and/or retrofitted (e.g., bridge crossings or drop structures) (habitat)
  - Stream-miles of enclosed channel daylighted or retrofitted, number of tributary miles connected to mainstem, or miles of stream channel restored (habitat)

B. Fish Habitat Goal: Restore or enhance fish and aquatic organism habitat from Lake Michigan to the headwaters and tributaries.

Objective 1: Enhance fisheries spawning sites in the Inner and Outer Harbors.

Objective 2: Insert Value-Added Habitat Projects as Possible with KK Concrete Removal (6th-43rd).

Objective 3: Reconnect [x amount] of high quality habitat downstream of the Bridge Street Dam and Lepper Dam to the main stem rivers of the AOC.

- Potential measures of success
  - Stream-miles of habitat protected and/or created (habitat)
  - Number of stream miles connected and functional as fish and aquatic organism habitat (habitat)
  - Number of native species present or some equivalent biological indicator (populations)
  - Area of adjacent floodplain reconnected for the 2-yr and 5-yr events (habitat)
  - Area of adjacent wetlands reconnected and/or restored/created (habitat)
  - Area of adjacent potentially restorable wetlands reconnected, as applicable (habitat)

C. Fish Population Goal: Restore a sustainable fishery for warmwater, coolwater, coldwater, and intermittent stream communities, as appropriate.

- Potential measures of success (all populations)
  - Number/proportion, type, and life stages of native species observed
  - Area cleared or tons removed of nonnative species
  - Total abundance
  - Shannon's diversity index

- Index of Biological Integrity (IBI) for various temperature and flow regimes (e.g., warmwater, coldwater, intermittent).
- Number and proportion of species intolerant to pollution
- Number and proportion of species tolerant to pollution
- Cool and warmwater transitional fish species

➢ Potential Umbrella Fish Species (all populations)

- Lake Sturgeon (Was extirpated and currently undergoing re-establishment; good long-term goal species representing connection between Lake Michigan and upstream mainstem of the Milwaukee River; benthic feeder, so also good candidate for achievement of sediment toxicity remediation; main stem river spawner, good candidate for assessing access to high quality main stem habitat, susceptible to impediments.)
- Northern Pike (Coolwater species; poor swimmer = good candidate for connectedness assessment, susceptible to impediments, particularly within and among headwater tributaries and wetlands; wetland spawner, especially good candidate for stream connectedness with riparian land, i.e., buffers.)
- Greater Redhorse (Threatened species; intolerant; benthic feeder = good candidate for water quality achievements and achievement of sediment toxicity remediation; main stem river spawner, susceptible to impediments = good candidate for assessing access to high quality main stem habitat.)

➢ Restoration of Fish Diversity

- Increases in native species richness (populations)

D. Non-fish Biodiversity Goal: Identify and enhance non-fish aquatic organism habitat from Lake Michigan to the headwaters and tributaries.

Objective 1: Identify non-fish aquatic organism status through surveys and conservation assessments (i.e., turtles, amphibians, mussels, odonates, crayfishes, aquatic plants, etc.)

Objective 2: Restore non-fish aquatic biodiversity where opportunities exist.

➢ Potential measures of success

- Number of existing critical habitat areas identified and protected, enhanced, reconnected, or re-created (habitat)
- Number of native species present or some equivalent biological indicator (populations)
- Number of species of local conservation interest (SLCIs) restored or enhanced (populations)
- Increase in species richness (populations)

II. Land-Based Measures

A. Wildlife Habitat Area Goal: Expand riparian buffer width to a minimum of 75 feet; where possible, expand buffer 400 feet to 1,000 feet to meet core or habitat area needs.

- **Potential Measures of Success**
  - Stream-miles inventoried and area of potential suitable buffer habitat identified (habitat)
  - Stream-miles with suitable buffer habitat width of 75 feet or greater preserved or established (habitat)
  - Volume of historic fill and/or tons of trash removed from riparian areas (habitat)
  - Area of native wetland or upland suitable habitat reconstructed (habitat)
  - Area of Advanced Identification of Wetland Disposal Areas (ADID wetlands), upland within PEC, and/or 100-yr floodplain limits protected (habitat)
  - Number of native species restored (populations)
  - Area of exotic invasive species removed (habitat)

B. Wildlife Habitat Connectivity Goal: Expand riparian buffer continuity (connectedness).

- **Potential Measures of Success**
  - Stream-miles of continuous suitable buffer habitat widths of 75 feet or greater preserved or established (habitat)
  - Number of riparian area crossings and/or impediments removed and/or retrofitted to improve or restore continuity of riparian buffers, including improvements to decrease resistance to animal movements (habitat)
  - Increase in suitable habitat patch size resulting from new connectivity (habitat)

C. Wildlife Habitat Goal: Protect high-quality areas or environmentally sensitive lands.

- **Potential Measures of Success**
  - Stream-miles inventoried and area of potential buffer identified. (habitat)
  - Stream-miles or area of land protected (habitat)

D. Terrestrial and Semi-aquatic Biodiversity Goal: Identify and restore or enhance terrestrial and semi-aquatic organism habitat in the AOC.

Objective 1: Identify terrestrial and semi-aquatic organism status through surveys and conservation assessments (i.e., birds, mammals. reptiles, amphibians, insects, crayfishes, etc.). (populations)

Objective 2: Restoration of terrestrial and semi-aquatic biodiversity (populations)

- Potential measures of success
  - Areas of existing critical habitat areas identified and protected, enhanced or mitigated (i.e., den sites, breeding sites, foraging sites, minimum viable habitat patch size areas, etc.) (habitat)
  - Number of SLCIs identified as potentially sustainable in the AOC. (populations)
  - Additional areas of new critical habitat restored or created in the AOC. (habitat)
  - Number of native species present or some equivalent biological indicator (populations)
  - Number of SLCIs restored or enhanced in the AOC (populations)
  - Increases in species richness or populations achieved in the AOC (populations)

E. Hydrology Goal: Moderate flow regimes to decrease flashiness.

- **Potential Measures of Success**
  - Numbers of detention and infiltration basins installed, drainage area controlled by regenerative stormwater practices that achieve quality and quantity control, area of permeable paving materials installed, acres of wetland and upland restored, area of low-impact development
  - Number of rain gardens or rain barrels installed and downspouts disconnected, green roofs installed
  - Drainage area controlled by regenerative stormwater practices that achieve quality and quantity control and numbers of basins inspected and maintained (%TSS reduction as indicated by WinSLAMM analysis after improvements implemented)
  - Miles of stream connected with the floodplain
  - Decreases in average flow magnitude, high flow magnitude, high flow event frequency, and/or high flow duration
  - Improvement in flashiness index

F. Hydrology Goal: Provide and preserve sufficient baseflow.

- **Potential Measures of Success**
  - Area of groundwater recharge protected
  - Improvement in flashiness index
  - Number of flow deflectors installed, pipes cut back from streambank, or land area treated by infiltration practices